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2001

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Chun-Hsuan Wang
Iowa State University

James Kliebenstein
Iowa State University

Arne Hallam
Iowa State University

Jeffrey Zimmerman
Iowa State University

Vina Diderrich
Iowa State University

See next page for additional authors

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Extension Number: ASL R693

Recommended Citation

Wang, Chun-Hsuan; Kliebenstein, James; Hallam, Arne; Zimmerman, Jeffrey; Diderrich, Vina; Patton, Sharon; Faulkner, Charles; McCord, Raymond; and Bush, Eric, "Levels of *Toxoplasma gondii* in Swine Operations" (2001). *Swine Research Report, 2000*. Paper 49.

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Authors

Chun-Hsuan Wang, James Kliebenstein, Arne Hallam, Jeffrey Zimmerman, Vina Diderrich, Sharon Patton, Charles Faulkner, Raymond McCord, and Eric Bush

Levels of *Toxoplasma gondii* in Swine Operations

Chun-Hsuan Wang, graduate student;

James Kliebenstein, professor;

and Arne Hallam, professor,

Department of Economics;

Jeff Zimmerman, associate professor,

Department of Veterinary Diagnostics,

Iowa State University;

Vina Diderrich, graduate student,

Sharon Patton, professor;

Charles Faulkner, professor;

and Raymond McCord, professor,

Department of Comparative Medicine,

University of Tennessee;

Eric Bush, researcher,

National Animal Health Monitoring System

ASL-R693

Summary and Conclusions

Results from this and other studies have shown a clear association between pork production systems that are accessible to *Toxoplasma gondii* vectors, such as cats, and seropositivity of hogs for *T. gondii*. Sows and market hogs in pork production systems that had total confinement facilities in phases (farrowing, nursery, finishing) were significantly less likely to be seropositive for *T. gondii*. Of the market hogs tested, 4.4% from nonconfinement facilities were positive compared with 2.3% of the hogs from all confinement facilities. Pigs produced in systems that used bait and/or traps as the only method of rodent control had significantly fewer animals seropositive for *T. gondii*.

Reducing the level of toxoplasmosis can have a direct impact on consumers. Given this, and the lack of direct economic incentives for pork producers, industry programs would be helpful in assisting consumer and producer benefits to better match. Moreover, consumer assurance of the safety of pork is vital to continued and enhanced demand for pork, both domestically and internationally. Moreover, there is an increased consumer awareness of foodborne pathogens. The demand for safe food products is increasing. A *T. gondii* food-safety incident related to pork would erode the consumer image, potentially leading to reduced demand, at least in the short term. The industry needs to evaluate methods of reducing cat accessibility to pig production systems.

Introduction

Toxoplasma gondii is infectious for essentially all warm-blooded animals, including mammals, marsupials, and birds. In humans, prevalence is commonly 25 to 50% and, depending on the population studied, may approach 80%. Roberts and Frenkel have shown that toxoplasmosis has been estimated to cost United States consumers from \$.4 billion to \$8.8 billion per year. Infection in healthy children and adults is usually subclinical and generally passes unnoticed. The greatest concern for humans is congenital infection. Infection under these circumstances may cause stillbirths, abortions, early infant mortality, blindness, and crippling in children.

Like humans, swine become infected by ingesting oocysts from the environment or by consuming raw or under-cooked meats that contain bradyzoites, such as *Toxoplasma*-infected rodent carcasses. Toxoplasmosis is common in domestic swine throughout the world. Recent reports provide prevalence estimates that range from 3.1 to 20.8% (Kliebenstein et al., 1997; Patton et al., 1996; Lin et al., 1990). The frequency of infection in swine is distinctly age dependent, with prevalence in market animals approximately half (3.1 to 9.0%) that of sows (9.4 to 20.8%).

Toxoplasmosis in swine is a food safety issue, as opposed to an animal health issue. From the consumers' perspective, toxoplasma-free pork is a more desirable food product. Likewise, from the pork producers' perspective a commodity perceived as safer and more wholesome gains a competitive advantage in the marketplace. The purpose of this study was to identify herd characteristics and farm management practices associated with reduced toxoplasmosis in swine with the purpose of formulating recommendations for the prevention of the infection in swine.

Materials and Methods

Data for this study were obtained from a random survey of swine herds conducted by the National Animal Health Monitoring System (NAHMS) during 1995. As part of the study, general farm management information and blood sera were collected from 285 swine producers in 16 states. These data included specific information on production facilities, biosecurity measures, management practices, and pig inventory. Sera were collected from sows and market hogs.

Among the 285 herds participating in blood sera collection, serum samples were collected from sows in 226 herds and from market hogs in 282 herds. Serum samples from up to 30 randomly selected animals were collected from each herd; 15 from sows and 15 from market livestock. After collection, samples were archived at the United States

Department of Agriculture (USDA), National Veterinary Services Laboratories (NVSL) and stored at -40 C until assayed for serum antibodies against *T. gondii* by the University of Tennessee Parasitology Laboratory. A total of 3,236 individual sow serum samples and 4712 individual market hog serum samples were assayed for the study.

Because some samples were of poor quality, and sampling error where less than 10 animals were sampled, not all farms were used in the analysis. If sow herds had less than 10 sows with test results and all tested negative, they were dropped from the analysis because the probability of all sows in the herd testing negative was considered too low to be labeled as a negative herd. Herds with at least one sow that tested positive were retained as a positive herd for analysis. The same convention was followed for finishers with less than 15 tested being the number that excluded a herd from advanced analysis when all animals were negative. A herd was considered positive if one or more animals tested positive. For both sow herds and market hog herds, all animals tested needed to be negative to be considered negative.

Results and Discussion

Eight percent of all swine tested for *T. gondii* antibodies were positive. Fifteen percent of the sows tested positive, whereas 3.2% of the market hogs tested positive (Table 1). The prevalence rate was significantly higher in the sow herd (approximately five times higher) than in the market hog herd. A NAHMS survey of sows compiled in 1990 showed that 20% of the sows were positive at that time. Market hogs were not surveyed in 1990.

Of the farms, 51% had at least one animal positive for *T. gondii*. Of the sow herds tested, 56% were positive whereas 19% of the market hog herds tested were positive (Table 1). The percentage of sow herds testing positive was similar between 1990 and 1995. In Iowa in 1995, 18% of the sows were positive, whereas 5% of the finishers were positive.

When comparisons were conducted by herd size it showed that negative sow herds were significantly larger than the positive herds. The negative herds averaged 647 sows, whereas the positive herds averaged 260 sows. Negative finisher herds averaged 3635 market pigs in inventory, whereas the positive herds averaged 2081 market pigs in inventory.

The analysis also focused on type of production facility and the type of rodent control used. For facility analysis, the swine herds were placed into two groups: those which had total confinement for all production phases and those which had at least one of the production phases in which pigs had access to the outside through open buildings or direct access to the outdoors.

The *T. gondii* status of sows and sow herds with all production phases in confinement (farrowing, nursery and finishing) was compared to herds that were not in total confinement in at least one of the phases. Twenty percent of the sows in facilities which were not all in total confinement

had a significantly larger percent of sows test positive and were almost twice as likely to be infected than those in confinement: 12% infected (Table 2). Additionally, sow farms that had facilities that were not all total confinement had a significantly higher percent (.01 level) of herds test positive than did the total confinement operations. Seventy-one percent of the nontotal confinement herds were positive compared with 49% of the total confinement herds. Market hogs on farms that did not have all phases of the operation (farrowing, nursery, grower/finisher) in confinement were significantly more likely to be infected than those on farms that used total confinement throughout (Table 3). The prevalence level was essentially cut in half for the total confinement systems.

Sows and market hogs exposed to cats in the production facilities were significantly more likely to be positive for *T. gondii* than sows and market hogs not exposed to cats (Tables 4 and 5). Approximately one-fourth (21%) of the sows in systems that had cat exposure were positive for *T. gondii*. This compared with only 6.7% of the sows in facilities that did not have cat exposure. The odds ratio test indicated sows in facilities with cat exposure were about four times more likely to be positive. For market hogs the odds are even greater. Odds ratio analysis showed that market hogs produced in facilities with cat exposure were approximately nine times more likely to be positive. Information in Table 7 shows that 5.5% of the market hogs in facilities with cat exposure were positive. This compared with 0.7% for those produced in facilities without cat exposure. Similar results were obtained when evaluated by method of rodent control. Sows and market hogs produced in systems that relied on traps and/or bait only as the method of rodent control had significantly lower prevalence levels of *T. gondii*.

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Acknowledgements

We gratefully acknowledge and appreciate support from the National Pork Producers Council for partial funding, and the National Health Monitoring System staff for help in obtaining data and sera for analysis.

Table 1. Seroprevalence of *T. gondii* in sows and finisher pigs in the 1995 NAHMS Survey.

Swine Type	Animals			Herds
	Positive/ Total	% Positive	Positive/Total (a)	% Positive
Sows	488/3,236	15.0	126/226	56
Finishers	153/4,712	3.2	53/282	19
Unknown	3/13	10.0	-	-
Total	644/7,979	8.0	144/285	51

(a) Adding number of sow herds and finisher herds will be more than the total herds, because some farms had both sows and finishers tested.

Table 2. Comparison of *T. gondii* seropositivity in sows by production facility.

Facility Type	Number	Percent Negative	Percent Positive	P
Sow Comparison				
Total Confinement in All Phases	1884	88.4	11.6	<0.01
Not all Total Confinement	1149	79.8	20.2	
Farm Comparison				
Total Confinement in All Phases	128	50.8	49.2	<0.01
Not All Total Confinement	79	29.1	70.9	

Exclude 12 sow farms with incomplete facility information.

Table 3. Comparison of *T. gondii* seropositivity in market hogs by production facility.

Table 1. Comparison of P-gene sensitivity in market hogs by production facility.				
	Market Hog Comparison			P
	Number	Percent Negative	Percent Positive	
Confinement in All Phases	2096	97.7	2.3	<0.01
Not all Total Confinement	1334	95.6	4.4	
Farm Comparison				
Total Confinement in All Phases	129	83.7	16.3	0.17
Not All Total Confinement	84	76.2	23.8	

Exclude 46 finisher farms with incomplete facility information.

Table 4. Comparison of *T. gondii* seropositivity in sows by cat access to production facilities.

Item	Number	Percent Negative	Percent Positive	P
Sow Comparison				
Cat Access	1917	79.0	21.0	<0.01
No Cats	1241	93.3	6.7	
Farm Comparison				
Cat Access	132	31.8	68.2	<0.01
No Cats	84	59.5	40.5	

Exclude three farms with incomplete rodent control information.

Table 5. Comparison of *T. gondii* seropositivity in market hogs by cat access to production facilities.

Table 3. Comparison of <i>T. gondii</i> seropositivity in market hogs by cat access to production facilities.				
Item	Number	Percent Negative	Percent Positive	P
Market Hog Comparison				
Cat Access	2469	94.5	5.5	<0.01
No Cats	1943	99.3	0.7	
Farm Comparison				
Cat Access	148	72.3	27.7	<0.01
No Cats	108	89.8	10.2	

Exclude three farms with incomplete rodent control information.